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The Relationship Between Society and Commercial Aviation Industry: Electric and Private-owned Aircrafts

Introduction

There was a "golden quarter" that came about from post-World War II and Cold War periods and was the catalyst for the boom in electronics, civil rights movements, nuclear power, space travel, and mass aviation. It was an age from approximately 1945 to 1971 when speculation matched reality that defined or sowed the seeds to what came about of the modern world (Hanlon, 2014). However, the aftermath of this period saw what American economist, Tyler Cowen, described as a great stagnation that defined a generation of progress defined by incremental and often banal improvements (Hanlon, 2014). The same stagnation had infected the aviation industry, limiting technology to fuel efficiency. With fuel efficiency being critical to the future of the aviation industry, not just for environmental reasons but also financial ones, even incremental savings offer significant benefits overall (Efficient Technology). Even up until today, engineers and researchers have made incremental and frequent improvements that offer large savings overall but little dramatic innovations.

Through years of refining and optimizing aircraft design, many have felt that we as a society had reached a plateau in terms of aircraft performance when it comes to fuel efficiency and low emissions (Domone, 2018). However, air travel has entered a time that is about to experience a period of great change. Usually, a major industry-wide overhaul to passenger

experience occurs once every decade or two and we are currently in such a generational shift (Zhang, 2017). One instance was the integration of jet engines, a military technology, into passenger airplanes. Air travel was revolutionized by the introduction of the jet engine and is on course for similar revolution (Pushkar, 2002). Electric planes and privately-owned jets have taken leaps forward into shaping this generational shift. Electric cars serve to fill a need for greener and possibly more efficient short-term commute as so-called air taxi operations (Efficient Technology). Air taxi style electric airplanes and airlines could save significantly in the process by eliminating fuel cost and replacing current fleets with larger fleets of smaller aircrafts (Loeffler, 2019). Privately-owned jets serve as the spearheads for population mobility by wealthy elites to further stimulate population dispersion within the urban agglomerate (Isard, C., & Isard, W, 1945, p. 163). By combining the efficiency and economic friendly form of electric flight with the congestion alleviating transportation of privatizing flight, this paper will explore the foundations for the next potential shift in aviation. It will use the Social Construction of Technology as a mechanism of diagnosing where reverse salient are presenting an opportunity for social groups to position themselves as bringing fresh ideas to a stagnant industry.

Theoretical Framework

To understand the implications of the generational shift of incremental innovations to an industry-wide overhaul towards electric and privatization, the framework of Social Construction of Technology is used to examine the technological void assumed by society for technology to quench those needs in. I will begin with a case study of the De Haviland Comet, the first jet-powered passenger aircraft which represented technology behind a past generational shift of propeller-driven aircraft to jet engine (Pushkar, 2002). By analyzing the trends pushing for electric flight and private planes and the agendas of different social groups that shape and are

affected by this generational shift. By examining the social implications of the generational shift that overlapped the dawn of commercial aviation and the social and even economic implications of a potential industry-wide overhaul, it is possible to explore into a reasonable prediction of what the generational shift of this decade could entail.

Literature Review

In the Quarterly Journal of Economics, Caroline Isard and Walter Isard's, "Economic Implications of Aircraft," explores the implications for the impact of transport technology upon the United States economy. Isard C. and Isard W. claim that the aircraft, especially privately owned air-craft, would be the catalyst in population transportation for vast changes in urban metropolitan trends and patterns (Isard C. and Isard W, 1945, p. 162). This journal that was published in 1945 suggested that privately-owned aircraft, despite under difference circumstances, would become the next shift in transportation once efficiency was satisfied. They believed that aircraft technology would become more efficient as the industry would break barriers and allow for middle class people to actively participate in a revolutionary movement. Walter and Caroline Isard believed that the obstacles the assimilation of private aircraft could face would be technical, rather than economic, as they predicted that production and operation cost would permit mass adoption and combat congestion inherent in mass commutation (Isard C. and Isard W, 1945, p. 156). Meanwhile, other researchers also come to believe that society is still unprepared for privately-owned jets and their wealthy owners to lead the mass into such urban agglomerations. For the time period, high-emissions and controversy surrounding climate change would not have been considered, but with the current younger generation emphasizing climate change, current private jets are becoming unattractive (Wagner 2019).

James Domone, a senior engineer at an engineering consultancy, claims that technological innovation has reached a plateau in terms of fuel efficiency and low emissions and the answer to the new problems to will be found in greener solutions. However, in searching for those solutions, the large diversity of available options to replace inadequate system parts have contributed what appears to be stagnation. Domone states that even if a suitable battery technology does not emerge, there will be other options for systems to switch from kerosene to hydrogen (not without its own challenges) (Domone, 2018). Moreover, the prospect of radically changing aircraft and airport design was raised, allowing air travel to more intercity transportation. Domone suggested that a hybrid-powered solution is much more likely to be available sooner which could deliver real benefit through reduced emissions. This hybrid-powered solution would set the stages for the development of electric propulsion motors and electronics to transition to full electric operations. Domone links the technological plateau as the catalyst for breakthrough with the solution of less fossil-fuel reliant technology with hybrid electric propulsion aircrafts.

These studies link the mutual relationship between people and technology, from fuel efficiency innovation for commercializing air transportation to the technological breakthrough in ecofriendly innovations emerging from a technological halt. Caroline and Walter Isard incorporate the cost framework to assume, potentially predict, the integration of privately-owned aircrafts into middle class society to urbanize population patterns as Domone suggests the need for the next leap in technological breakthrough to spearhead the next generational shift with potential electrical propulsion aircraft.

De Havilland Comet: the First Jet-powered Passenger Aircraft

In order to understand the dawn of a new generational shift, a closer examination on a past generational shift can offer insight onto the upbringing and implications of a past generational shift. When World War II ended, the Allies were left with a surplus of military aircraft which met the satisfaction of the general public whom gained an interest, almost obsessive, fascination of flying (Morris, 2019). In the 1930s, commercial flight was far from luxurious and the wealthy income group wanted a faster and exclusive mode of commercial flight that the current propeller engine technology could not satisfy (Ellis, 2018). It was time for the jet engine of military aircraft to integrate into commercial aviation. Post-World War II left Britain severely behind in industrial capacity and lagging behind in their aviation industry to their American counterpart (Beresnevicius, 2019). In 1945, the British government contracted de Havilland, a British aerospace engineer and aviation pioneer most famous for producing the iconic Mosquito warplane, to design and produce an aircraft with a pressurized cabin, which could reach 400 miles per hour and fly across the Atlantic Ocean (Ellis, 2018). This monumental aircraft would be known as the Comet.

On May 2nd, 1952, the de Havilland Comet took its first commercial flight with the British Overseas Airways Corporation (BOAC) and shocked the world, becoming the first jet engine commercial aircraft (Beresnevicius, 2019). The Comet looked like an aircraft from the future, with a mirrored aluminum fuselage and swept back wings concealing four jet engines with a cruising altitude of up to 40,000 feet (Hollingham, 2017). The Comet and its sleek jet engine design and integration flew faster than any other aircraft of the time, making propeller driven planes look obsolete. The Comet's design allowed for only 36 passengers, reflecting the fact that air travel was, of course, still a preserve of the wealthy (Morris, 2019). While modern planes are very much constructed with economics as the driving factor, the de Havilland Comet

was designed purely by engineers to achieve technological breakthrough and intended to provide passengers with the most comfortable and luxurious experience possible. Because of this, the Comet was notorious for its massive fuel consumption and limited range. Moreover, the Comet's ingenuity and lavishness was stained with a multitude of technical issues and fatal crashes (Pushkar, 2002). It pushed the limitations of the technology of its time to satisfy not only the passengers (wealthy ones included) for faster and extravagant flight experience, but also raise recognition in British aviation industry. The last Comet was built in 1964 and eventually grounded due to massive technical issues and became notorious for its engineering and commercial failure (Beresnevicius, 2019).

The de Havilland Comet was an aircraft that was too ahead of its time. The technical limitations of the time period led to errors and flaws in integration and usability. Despite its major failure, it is still regarded as a technological breakthrough. Today's jet aircraft owe a huge amount of to the de Havilland Comet. It taught the lessons that other manufacturers learned to paved the way for modern safety and design (Hollingham, 2017). Being the first commercial jet powered aircraft, it paved the way for the modernization of the jet engine in decades to come (Morris, 2019). The monumental effect of the massive industry wide overhaul of passenger experience from propeller engine to jet engine represented a generational shift post World War II.

Electrification and Privatization

Since the dawn of aviation, planes have primarily used carbon-based fuels such as gasoline and kerosene (Wilson, 2015). According to the European Commission, airplane emissions currently account for about 3% of total EU greenhouse gas emissions, and about 4% of world greenhouse gas emissions (Gaj, 2015). Experts suggest that if current technology isn't

advanced, then CO_2, output from aircraft will likely increase by two and a half times (Domone, 2015). With oil resources declining and greenhouse gas emissions increasing, the future of aviation is dependent on finding an alternative power source. Moreover, a transportation gap that most airlines aim to fill are short distance flights, roughly within a range of 600 nautical miles, which comprise of less than half of all flights flown every year (Loeffler, 2019). These short distance shuttle flights are incredibly inefficient since take-off and landing produces about 25% of the flight's total emissions, amplifying the inefficiency of short distance flights. Moreover, the wealthy consumers of private jets are being tormented by eco-guilt and are considering sustainable alternatives to the risk mitigators of flexible travel private jets offer (Parker, 2015). This eco-guilt can have a significant impact on the industry itself and a market for the high-income class is important. This also opens an avenue to intercity journeys that helicopters are too inefficient to commercialize.

With sustainability and private flights becoming a trend, the rise in popularity for greener technology and new methods of transportation are taking place. Manufacturers are changing aircraft and airport design to allow for cheaper, quieter, and cleaner intercity commute (Domone, 2015). With climate change being a legitimate issue, passengers want to contribute to reducing emissions (Wagner, 2019). Electric powered planes serve to maximize the use of electricity to significantly reduce fuel consumption and improve overall energy efficiency while improving aerodynamics and optimizing the flight profile to use less fuel (Wilson, 2015). In practice, this means reducing the weight of the aircraft, reducing drag with improved aerodynamics and optimizing the flight profile to use less fuel. Despite not having clear estimates of usage, the negative impact of electric planes on the environment is next to none. There is no need for the burning of fossil fuels of any kind, cutting down carbon emissions (LeBlanc, 2019).

From the passenger's perspective, electric aircraft are a massive win. The new planes would result in cheaper tickets, decreased noise pollution, and higher rates of climb. With an electric engine, planes are able to maintain performance at higher altitudes where the air resistance is less, unlike combustion engines that operate less efficiently at these altitudes (Gaj, 2018). Among those passengers, the high-income users (even owners) of private planes feel guilty about using high emission private jets and also relate to the need for greener solutions (Wagner, 2019). For short-haul flights, higher-up executives also understand the high emissions released from helicopters inner city travel and similarly to their peers, want to contribute to reducing damage to the environment. Moreover, because of the difficulty of flying electric for great distances, many manufacturers envision a different way of traveling around urban areas (LeBlanc, 2019). For the common passenger, speed is not as much of a concerning factor compared to cost, while wealthy executives will prioritize time and speed over cost. Electrification can serve to satisfy both social groups.

From the perspectives of airlines and other companies with similar services, these flights are a prime candidate for electrification since electric airplanes with a range of about 600 nautical miles will be available much sooner than those capable of longer ranges (Loeffler, 2019). They may be smaller than standard aircraft, but the reason why airlines try to pack as many passengers into an aircraft is more about trying to optimize fuel costs than it is anything else. By Eliminating the fuel cost of and replacing current jets with a much larger fleet of smaller, air taxi style electric airplanes, airlines could potentially save significantly in the process (Loeffler, 2019). Airlines are not intimidated by this integration as there are many small, local airports that don't have passenger flights leaving from them, potentially making the perfect hubs for short distance electric flight (LeBlanc, 2019). Some manufacturers plan to have planes land

and take off from the top of buildings, introducing urban air taxi services. Moreover, manufacturers are also electrifying its short to medium range aircraft with capacities of 60 passengers or less, exactly the kinds of planes used in the short-range commuter and business flights whose emissions are such a problem (Loeffler, 2019). Another relevant social group that has a significant impact in the rise of privatization and electrification are the stakeholders of the jet charter industry. Accounting for inflation, each private jet brings in over $85,000 into the local economy (Gollan, 2019). The industry is responsible for 10% of all jobs around the world and $8.8 trillion in contributions to local economies. Irresponsibly disrupting this market via flight shaming and eco-guilt is a global threat to the economy. Airlines, manufacturers, and other companies need to find an alternative to fossil fuels to not only maintain their businesses but also satisfy different subgroups among their consumers, passengers, and even environmentalists.

As the issue of climate change becomes more serious and the rise of emissions from current trends in air travel, consumers are pushing for sustainable and eco-friendly solutions to contribute to reducing environmental damage without sacrificing the flexibility and luxuries current commercial aviation offers. By encouraging manufacturers to push for such technologies, electrification is the answer as it satisfies both airlines and users in terms of efficiency, cost, and sustainability. Despite current technology in electric aircraft is still in its infancy, the push for integration has opened a new niche for short distance travel that the private plane market can enter. It is currently impossible to scale the impact of electric airplanes and until full electric powered airplanes can be integrated for long distance flight, this niche will be the ground zero for the next generational shift in aviation technology going beyond the plateau of incremental innovations.

Conclusion

With the current technology on pace to shape the next generational shift, it is not without surprise to expect electrification and privatization of flight. Society wants to contribute to help mitigate climate change, almost begging for electrification. Current electric technology is still in development and it may take several more decades for fully electric modes of transportation to be integrated into our regular commute, but the short haul destinations it can fly open up opportunities for jet charters to tap into and still maintain its impactful market. A hybrid-powered solution is much more realistic and eminent in availability. Electrification is the technology that will go beyond the plateau of incremental innovation, even almost stagnation, and privatization can serve to assist in commercializing it. Engineers must discover a universally accepted option to technological breakthrough to overcome the large diversity of available options in replacing inadequacies in current systems. Alongside understanding the technological barriers and breakthroughs, change of this nature will be, without doubt, disruptive right across our industry and forward-looking companies must be prepared to face the biggest challenge of integration. It is still up for debate on what the next generational shift will turn out to be. Another perspective to take into consideration is the military industrial complex as many commercial technologies emerge from military use.

References

Beresnevicius, R. (2019, February 11). *Aircraft That Brought The Future – de Havilland Comet*. https://www.aerotime.aero/rytis.beresnevicius/23055-aircraft-brought-future-de-havilland-comet

Bijker, W. E., Hughes, T. P., & Pinch, T. (Eds.). (2012). The social construction of technological systems : New directions in the sociology and history of technology. Retrieved from https://ebookcentral.proquest.com

Domone, James. (2018). *The Challenges and Benefits of the Electrification of Aircraft*. https://www.atkinsglobal.com/~/media/Files/A/Atkins-Corporate/Electrification%20White%20Paper%20-%20digital.pdf

Efficient technology. (n.d.). Retrieved February 12, 2020, from https://aviationbenefits.org/environmental-efficiency/climate-action/efficient-technology/

Ellis, C. (2018, August 16). *A look back at the De Havilland Comet—Air Charter Service | Air Charter Service*. https://www.aircharterservice.com/about-us/news-features/blog/a-look-back-at-the-de-havilland-comet-the-worlds-first-commercial-jet-airliner

Gaj, E. (2018, July 8). The electric aircraft is taking off. *TechCrunch*. http://social.techcrunch.com/2018/07/08/the-electric-aircraft-is-taking-off/

Glancey, J. (2014, April 14). *The crashes that changed plane designs forever*. https://www.bbc.com/future/article/20140414-crashes-that-changed-plane-design

Gollan, D. (2019, August 22). *Private Jet Travel Is Greener Than You Think*. https://www.forbes.com/sites/douggollan/2019/08/22/private-jet-travel-is-greener-than-you-think/

Hollingham, R. (2017, April 5). The British airliner that changed the world. Retrieved October 14, 2019, from https://www.bbc.com/future/article/20170404-the-british-airliner-that-changed-the-world

Isard, C., & Isard, W. (1945). Economic Implications of Aircraft. *The Quarterly Journal of Economics*, *59*(2). https://doi.org/10.2307/1884823

Hanlon, Michael. (2014, December 3). *Has progress in science and technology come to a halt?* https://aeon.co/essays/has-progress-in-science-and-technology-come-to-a-halt

LeBlanc, R. (2019, March 4). Will Electric Airplanes Make Travel More Sustainable? https://www.thebalancesmb.com/will-electric-airplanes-make-travel-more-sustainable-4176147

Loeffler, J. (2019, March 3). *Why We Need To Start Developing Electric Airplanes Right Now*. https://interestingengineering.com/why-we-need-to-start-developing-electric-airplanes-right-now

Morris, C. (2019, December 25). *The Story Of The De Havilland Comet—The World's First Jet Airliner*. https://simpleflying.com/de-havilland-comet-first-jet/

Parker, T. (2015, June 30). *The Economics of Private Jets*. https://www.investopedia.com/articles/personal-finance/063015/economics-private-jet-charters.asp

Pushkar, R. (2002). Comet's Tale. Retrieved October 14, 2019, from Smithsonian website: https://www.smithsonianmag.com/history/comets-tale-63573615/

Robinson, T. (2017, December 1). *How E-Fan X will jump-start a new era in hybrid-electric flight*. https://www.aerosociety.com/news/how-e-fan-x-will-jump-start-a-new-era-in-hybrid-electric-flight/

Wagner, S. (2019, December 22). Can You Own a Private Jet If You Care About Climate Change? https://www.bloomberg.com/news/articles/2019-12-22/can-you-own-a-private-jet-if-you-care-about-climate-change

Wilson, Peter. (2015, August 24). *Are electric planes the future of aviation?* https://www.weforum.org/agenda/2015/08/are-electric-planes-the-future-of-aviation/

Zhang, B. (2017, October 11). *6 ways the future of flying will be amazing*. https://www.businessinsider.com/how-technology-is-changing-airline-indusry-2017-10